Chapter 11

Inspection and Maintenance

The extent of a bridge inspection depends on the combat situation and its influence on future plans for the bridge. If military use of the bridge will extend beyond the immediate tactical need or if the bridge is located on a main supply route (MSR), the inspection should be detailed enough to ensure the bridge's continued use. Experienced personnel must provide timely bridge maintenance to prevent the need for extensive repairs, prolong the life of the bridge, and preclude the closing of vital LOC. Such maintenance includes minor, routine repairs. It does not include replacing or reinforcing major superstructure or substructure members. *Chapter 4* describes methods of reinforcing and repairing existing bridges.

INSPECTION

11-1. Bridges to be abandoned or demolished in the immediate future require only a hasty inspection. An inspector must recognize the anticipated loadings, the combat exposure, and other pertinent factors. Bridges are inspected at least monthly and sometimes daily. The frequency of bridge inspections depends on many factors, such as the following:

- Mission.
- Bridge type.
- Traffic discipline.
- Traffic density.
- Bridge condition.
- Stream characteristics.
- Bridge importance.

MISSION

11-2. An inspection team may combine road and bridge inspections. Their mission is to—

- Determine the bridge's classification (if not posted) or to verify a posted classification.
- Determine the rate of deterioration and record the findings.
- Determine the maintenance and repairs required.
- Determine the means of reinforcement if the load-carrying capacity is inadequate.
- Check traffic control and discipline.
- Locate and check possible bypasses.
- Determine sources and availability of local materials.

PERSONNEL

11-3. Engineer reconnaissance officers (with practical knowledge of civilian bridges) should conduct the bridge inspections. The size of the inspection team ranges from one to five persons, depending on the scope of the inspection. A soil-testing expert may be part of the team. Include a civilian bridge expert (if available) for special problems on important bridges. Corps or higher HQ is the approving authority.

EQUIPMENT

11-4. An inspection party should have the equipment listed below. Other useful items that may be included (if qualified operators are available) are a surveyor's level and a soil-testing set.

- Map and compass.
- Camera and film.
- Shovel and pick.
- Tape measure.
- Sketching set.
- Stakes.
- Twine, cord, or rope.
- Knife or saw.
- Sounding rod.
- Pneumatic reconnaissance boat.
- Sign-painting kit.
- Report forms.

REPORTS

11-5. During the early tactical phase, there is seldom time to prepare a written report. Any oral reports should be followed with a written report as soon as possible. Only the most important bridges require an initial written report be prepared. Use *DA Form 1249* to record information (see *FM 5-170*). Include the information discussed in the remainder of this section and sketches, maps, and pictures (essential for clarity) in the report.

11-6. An inspection team should develop a checklist to use when conducting bridge inspections. The checklist should include all the items that are necessary to accomplish the objective of the inspection. If a bridge is determined to be unsafe during an inspection, the team should either lower the posted classification or close the bridge for repairs. The team must report such actions to the responsible engineer staff officer or commander. The inspection team forwards its report through the chain of command for distribution to the responsible unit. The team should also maintain a file copy of the report.

INSPECTION ITEMS

11-7. The items discussed below should be included in the checklist. The list is not in any particular order, but the team should check each item.

Attached or Hidden Demolition Charges

11-8. Check captured bridges for mines, demolition charges, or other evidence of booby traps or sabotage. Abutments, piers, truss chords, suspension cables, and arch crowns are likely locations for hidden explosives. Many foreign bridges have concealed chambers in structural members that may contain demolition charges.

Evident Damage

11-9. Check and record any evident damage. Even minor damage in critical areas can render a bridge unsafe.

Structural Alignment

11-10. Examine all structural parts of a bridge, especially bents, piers, abutments, and trusses. Check for misalignment and excessive settling. Check the expansion joints because they will show signs of a bridge shifting or misaligning. These conditions are likely to occur after hard rains and flooding. Check the vertical alignment of the approach roadway. The approach should match the level of the bridge's deck surface. Ensure that each stringer is carrying its share of the dead load. Check anchors for tautness and performance. Check railroad bridges and trestles for rail and tie misalignment, loose spikes and connections, and tie and ballast shift.

Debris and Debris Jams

11-11. Clear the deck of debris. Ice, mud, and other debris greatly increase impact stresses on all parts of the bridge. Ensure that the deck drains are clear of debris and in operable condition. Remove jammed debris from around the piers or other structural members. Debris around the piers can accumulate rapidly and has the potential to exert sufficient force to topple the bridge (especially in swift currents).

Material

11-12. The material condition should be checked as follows:

- **Timber.** Examine all timber members for rot, splits, decay, insect damage, warp, crushes, breaks, or other damage. The deck should be smooth; rough surfaces increase impact stresses on all parts of the bridge. Replace timber treads when 10 to 15 percent of the original surface has worn.
- **Steel.** Examine steel for excessive corrosion, twist, lateral buckling, metal fatigue, or other damage.
- **Masonry and concrete.** Examine masonry and concrete for excessive cracks, crack progression, bulge, crumble, or erosion. Progressive condition changes are important for estimating the deterioration rate. Some tension cracking in concrete is acceptable, but exposed reinforcing bars indicate poor concrete condition. Worn concrete or masonry surfaces can best be protected by asphaltic concrete.

Deflection

11-13. Check the bridge for span and pier deflection. The elevation of a painted target on the point in question can be calibrated to a special benchmark with a good quality surveyor's level rod. Immediately investigate any change in the bridge's elevation. Deflection of the bridge under capacity loads should be no greater than 1/200 of the span length.

Connections

11-14. Examine all connections (nails, bolts, rivets, clamps, scabs, bracing, and so forth) for signs of looseness, wear, or other defects. Check the bolts and rivets carefully for early signs of shear. Check the lashings and riggings for improper tension and excessive wear. Consider the following:

- **Bracing.** Turnbuckles permit adjustment of diagonal tension rods. Tighten the adjustments so that the tension is uniform in all rods.
- **Joints.** Replace riveted or welded joints that are overstressed in shear. Tighten any loose, structural, ribbed bolts.

Fire Protection

11-15. Ensure that adequate fire-fighting equipment and supplies (fire extinguishers, water pumps, sand, and so forth) are available to the bridge guards. Ensure that the guards have been trained in the proper use of the equipment. Ensure that all dry grass and other combustible debris have been removed or neutralized. Investigate any incidents of floating fuels or conditions that may indicate fuel spills near the bridge.

Night Markers

11-16. Check the reflecting buttons or markers on the bridge. The markers should be adequate in number, firmly attached, clean, and properly located.

Classification

11-17. Ensure that bridges are classified according to *Part Two* of this FM. If signs of structural damage or additional damage not previously identified and considered for classification purposes are present, reclassify the bridge. If the accuracy of the posted classification is questionable, reclassify the bridge.

Bridge Signs and Approaches

11-18. Ensure that bridge and classification signs are present, accurate, clean, and visible. Check the bridge approaches for adequate turnouts.

Erosion

11-19. Check around all the abutments, piers, and anchors for signs of erosion. Examine the soil around these structures for signs of progressing erosion that may later damage or endanger the bridge structure. Floating objects such as ice, logs, and other debris can seriously damage or erode piers and other parts of the structure that are at water level.

Waterway Bottom

11-20. Check the waterway bottom for shifts of sandbars and channel. Monitor the hydraulic effects that wrecks, sunken boats, or other structures have on the bridge.

Detours and Bypasses

11-21. Compile or update information on alternate routes. This information is necessary during emergency conditions.

Snowdrifts

11-22. Indicate where snowdrifts could occur. Develop countermeasures for dealing with them.

Material Sources

11-23. Compile a list or update a previously made list with the location, type, and quantity of locally available materials. This list should include materials that are necessary for repairs.

CORRECTIVE MEASURES

11-24. An inspection-team chief should make recommendations for correcting all of the deficiencies noted during an inspection. The extent of the recommendations will depend on the materials, time, and personnel available and the methods adopted by the engineer staff or commander responsible for the bridge.

MAINTENANCE

11-25. An engineer construction company or battalion will normally be responsible for bridge maintenance, depending on the length of the route or the amount of work to be done. Road and bridge maintenance are usually one mission.

11-26. A maintenance unit is usually a patrol or a gang. A patrol may be an individual or a small group that proceeds along a route to perform a single task (such as nailing down loose flooring). A gang may vary in size from one squad to a company or larger. Gangs are more practical than patrols because they spend more time in a single location, performing several tasks at the same time.

11-27. Organic and special engineer equipment may be augmented from depot stocks, supply points, or other units. Captured equipment, parts, and material should also be considered as possible resources. When speed is essential, stock items are best for efficient maintenance. The responsible commander should determine the best resources and methods for obtaining material.

DECKS

11-28. Decks should be free of stones, mud, ice, and debris to decrease wear on the surface. Keep flat decks clear with a patrol grader, which throws mud,

ice, and debris to the curb where it can be removed by hand shoveling. A scarifier may help remove ice. If patrol grading is impractical, shoveling and hand removal of large debris is necessary.

11-29. A thin tar or asphalt coating densely covered with sand, pea gravel, or stone chips will reduce the danger of fire on wooden decks. Loose sand, chemical fire extinguishers, water pumps for river water, or barrels of water are effective resources for fighting bridge fires.

11-30. Misalignment (caused by simple shifting or structural failure) can be repaired by pulling the deck back into place with wire cable and tractors. Mechanical or hydraulic jacks may be effective. Misalignment of major superstructure members is usually caused by movement of the footings. Since this type of misalignment is difficult to repair, the bridge may have to be reconstructed.

11-31. The principles of fire fighting, shifting, and stringer replacement in highway bridges also apply to railroad bridge decks. Replace burned or damaged ties promptly. Check the rail alignment and guardrails for shifting and correct any problems. The maintenance patrol or gang should also tighten all loose rail spikes, end joints, hook bolts, and tie-spacer connections.

Fastenings

11-32. Wooden decks tend to shift under load. Correct this problem by adding adequate fastenings to the curb rail, tread, or stringers. If the stringers shift, draw them back into position and secure them with drift bolts (for timber stringers) or steel bolts (for steel stringers). Redrive any loose nails or add new nails to loose planks. Driftpins or lag screws might be needed in troublesome spots. Ensure that the clamps for the curbs and handrails are secure.

Timber Treads

11-33. All types of timber-deck bridges should have timber treads. Bolt timber treads onto steel grid floors if the grids show signs of excessive wear. Replace the treads when 10 to 15 percent of the original surface has worn. A tar or an asphalt coating covered with sand, fine gravel, or stone chips will prevent excessive splintering and rapid wear.

Wearing Surfaces

11-34. Asphaltic concrete best protects wearing surfaces of concrete or masonry.

Stringers

11-35. Replace bent, crooked, or rotten stringers by removing and replacing the flooring planks. Correct stringer bearing is essential for the bearing cap and the flooring. Placing metal shims between the stringer and cap is the best way to correct the bearing. Securely fasten shims in place to prevent them from dislodging. Do not use small shims between the flooring and stringers.

Curbs and Handrails

11-36. Replace curbs and handrails only when they have been damaged by accidents.

FOUNDATIONS

11-37. Foundation settlement is usually caused by scour or structural failure. Correct minor settlement by jacking up the structure and inserting steel shims between the stringers and the cap or between the bearing plates and the pedestal. Use hardwood shims under wooden members. Correction of settlement is discussed below. Scour prevention and methods for protecting the foundation and bridge supports from ice and floating debris are discussed in *Chapter 7*.

ABUTMENTS

11-38. Treat scour and settlement of abutments the same as foundation settlement. However, since an abutment also acts as a retaining wall, it is subject to horizontal earth pressures. If the abutment is unstable, shore it or hold it in place with guy lines from anchors on shore (discussed in *Chapter 8).*

TIMBER

11-39. Decay, excessive loads, structural defects, fire, or explosives may cause timber members to fail. Untreated timbers that are alternately wet and dry or are only partly saturated decay quickly. Timber that is under water or otherwise continually wet does not decay, but may be attacked by marine borers. Replace all timber showing decay or structural damage (preferably with masonry or steel) especially if the timber is in contact with the ground. One method of repairing piling is to splice new members to solid members with butt joints and scabs.

11-40. To allow timber to breathe, leave at least a 1/8-inch clearance between the timbers (where possible). Keep all bridge timber clear of debris. Remove the bark from native logs if this was not done during construction. Green or wet timber shrinks considerably when seasoned. Repeated wetting and drying also cause dimension changes as great as 5 to 10 percent, parallel to the grain. Unseasoned timber may require frequent renailing and tightening of bolts.

STEEL

11-41. Intense heat that raises steel temperatures above 1,000°F is particularly serious when the members are under stress. Members under tension that are heated to this extent will permanently elongate and if under compression will buckle. Intense heat will also destroy the temper and extra strength in certain types of steel (especially cold-rolled sections and high-strength wire). Replace damaged steel or reinforce it by welding new members onto the damaged sections.

11-42. Bending (due to accidents or explosions) is not as serious in members that are under tension as it is in those that are under compression. Straighten the bent compression members to their original shape. If not possible, weld or bolt steel plates or shapes onto the bent member to increase its stiffness.

When essential members are severed, other members assume added stresses. Relieve overstressing of members by adding bolted or welded plates or structural sections across the gap.

11-43. Military loads and design stresses are high, with impact adding to the severity of steel stresses. Fatigue failure is caused by repeated stressing and may result in sudden collapse. Fatigue failure is usually preceded by small hairline cracks around the rivet holes, welds, and other surface irregularities. Since these cracks usually do not get large before ultimate failure, reinforce the affected components immediately with steel plates.

11-44. Rusting on bridges seldom requires special attention unless these structures are subject to salt spray or are located in humid climates. Keep all steel clear of debris, and limit timber-steel contact to a minimum to prevent rusting due to moisture retention. Loose rust is not serious, but deep pitting should be investigated. Paint areas that are subject to severe rusting and coat them with tar, asphalt, or thick grease. Remove all rust with a wire brush or by sandblasting before painting.

CONCRETE

11-45. Correct surface spalling on concrete with plaster or with a low-water-content mortar applied with a pneumatic sprayer. Extensive frost damage is usually not repairable. Rust flakes on reinforcing steel can exert considerable pressure when confined and will spall concrete along bars that are too close to the surface. Although seldom serious, repair this condition by chipping away the concrete, cleaning most of the rust from the bar, and grouting the area. Fires of 1,200°F and above that last for an hour or more cause spalling and cracks and reduce the strength. Replace the concrete if the damage is serious. Patch all holes and gaps that are caused by accidents or explosions.

Tension

11-46. Concrete tensile strength is negligible since resistance to tension is furnished by the reinforcing steel. Tension cracks crossed at right angles by reinforcing steel are not serious unless they are more than 1/8 to 1/4 inch wide, depending on the structural details. The repair of this condition is discussed in *Chapter 4*.

Compression

11-47. Compression creates a crushing failure that crumbles concrete, especially in columns. The repair of this condition is discussed in *Chapter 4*.

Shear

11-48. Repair concrete shear failure in rectangular members with tight steel bands. Do this only under the supervision of a structural engineer.

APPROACHES

11-49. Correct any settlement of approaches immediately. The grade line of unpaved approaches should be 1 inch above the grade of the deck. The grade line of paved approaches should be the same grade as the deck. Patch any

potholes immediately. When settlement occurs on railroad bridges, add ballast to the track (shorewards of the abutment) to keep the track from dipping.

11-50. Some waterways with flat grades and floodplains have a tendency to shift channel locations. Such shifts may deposit eroded material against the piers or erode the pier foundations or approaches. These problems can be controlled by earth or rock dikes or by piles strung with brush mats woven into wire cables.